THE CHEMISTRY OF HOUSECRAFT

BLACKIE AND SON LIMITED

22900165499

Digitized by the Internet Archive
in 2017 with funding from
Wellcome Library

https://archive.org/details/b29298829

84800

Med
K11785

CHEMISTRY
HOUSECRAFT

*A Primer of Practical
Domestic Science*

BY

LUCY HALL, B.Sc.

Headmistress, Girls' High School, Pontefract

AND

IDA LEYTON GREENWOOD, B.Sc.

Science Mistress, Girls' High School, Pontefract

BLACKIE AND SON LIMITED
50 OLD BAILEY LONDON
GLASGOW AND BOMBAY

8785

34692 478

WELLCOME INSTITUTE
LIBRARY
Coll. welMOmec
Call
No. QU

CONTENTS

Chap. Page

I. Carbohydrates—Starch, Cane Sugar, Grape Sugar, Fermentation of Sugar - - - 9

II. Fats and Oils—Soaps - - - - - 20

III. Examination of Proteids in White of Egg, Lean Meat, Cod or Haddock - - - 28

IV. Foods containing Proteid and Fat—Yolk of Egg, Herring - - - - - - 39

V. More Complex Foods—Milk, Cheese, Cocoa - 42

VI. Vegetables—Potato, Root Vegetables, Green Vegetables, Pulses - - - - - 53

VII. Fruits and Nuts - - - - - - - 63

VIII. Flour—Use of Yeast and Baking Soda in Bread Making, Baking Soda - - - 67

IX. Benger's Food—The Digestion of Starch - 77

THE CHEMISTRY OF HOUSECRAFT

CHAPTER I

THE CARBOHYDRATES: STARCH, CANE SUGAR, GRAPE SUGAR

Experiment.—Taste and examine the appearance of starch, pure cane sugar, grape sugar.

Starch is a common vegetable product made in the leaves of plants, and stored in storage organs, such as the underground stem of the potato and many seeds.

Cane sugar is obtained from the sugar cane. Grape sugar, or glucose, is a less-sweet sugar than cane. It is present in many ripe fruits.

Experiments.—1. Heat on crucible lids—

(*a*) Some potato starch.
(*b*) Some pure cane sugar.
(*c*) Some grape sugar.

Note.—Both the sugars melt when heated, forming colourless liquids. These decompose quickly, charring, boiling and expanding considerably. Steam and gases are given off, and the sugar catches fire. A black mass of carbon is left, which, if the sugar is pure, burns away when heated to redness. Grape sugar often leaves behind a greyish mineral ash. Starch behaves very similarly, except that it does not melt to a clear liquid.

2. Heat small portions of the three substances in test tubes.

Note.—The condensed steam is very clearly seen on the cool parts of the glass.

TEST FOR STARCH

Chemists try to find a test for every substance with which they are acquainted. The method is to put the new substance with any other substance they know, and see whether there is any marked change, such as change of colour or state. We test for starch with iodine.

Experiment.—Mix a little starch to a cream with cold water, pour into a porcelain dish, add brown iodine solution to it slowly, and notice the blue colour.

TEST FOR GRAPE SUGAR

There is no simple substance which gives a colour change with grape sugar; consequently chemists have tried whether any chemical actions are affected by its presence. Two classes of chemical actions are, first, the making of salts, second, the breaking up of salts with alkalis. Common ways of making salts are (1) neutralization of acids and alkalis, (2) action of acids on metals, (3) action of acids on metal oxides.

When a salt, for example copper sulphate, is treated in solution with caustic soda solution, and the mixture heated carefully, black copper oxide is produced, and sodium sulphate crystals can be obtained. If a soluble lead or zinc salt be taken, a white precipitate is obtained, which, when filtered off and heated dry, can be recognized as lead oxide or zinc oxide.

It is the first of these actions which is found to be affected by the presence of grape sugar.

Experiments.—1. Take in a test tube a little copper sulphate solution, add plenty of caustic soda solution, heat carefully, and notice the black copper oxide formed.

2. Take in a test tube a little copper sulphate solution, add plenty of grape sugar solution and plenty of caustic soda solution; warm gently; the black oxide is no longer formed, but there is a red mixture in the test tube.

TEST FOR CANE SUGAR

There is no single substance which gives a test with cane sugar, and it does not affect a chemical action in the way that grape sugar does. An indirect test has been found. All who are familiar with cooking know that acid fruits, when cooked with sugar, require more sugar to make them sweet than if cooked alone and the sugar added when the cooking is over. It is probable that the acid in the fruit has acted on the cane sugar in the process of cooking and rendered it less sweet.

Experiments.—1. Test the cane sugar solution with copper sulphate and caustic soda as before. The red substance is not formed.

2. Boil up a little cane sugar in a small beaker half-full of water to which a few drops of strong hydrochloric acid have been added. After a few minutes boiling, test the solution with copper sulphate and caustic soda solutions. The red mixture will be formed, showing the presence of grape sugar.

The effect of acid and heat has been to change the cane sugar into the less sweet grape sugar.

HOUSEHOLD SUGARS

Experiment.—Test Demerara, ordinary lump, granulated, icing, white moist, yellow moist sugars for grape sugar as before.

Most are found to contain grape sugar. From their taste we know that cane sugar is present also.

ACTION OF WATER ON SUGAR

Sugars dissolve in cold water, and more quickly in hot water, making clear solutions.

EFFECT OF WATER ON STARCH

Experiments.—1. Put a little starch in a test tube, add cold water and heat gradually.

Note.—Various results will be obtained according to the relative amounts of starch and water. It can be seen that the starch does not dissolve easily, and has a peculiar action with boiling water.

2. Mix some starch to a thin cream with cold water, filter. Test the filtrate with iodine. Starch is seen to be insoluble.

3. Take about a teaspoonful of starch. Mix to a smooth thick paste with cold water; slowly add boiling water, stirring all the time.

Starch jelly is produced.

4. Take about a teaspoonful of starch, add boiling water and stir.

Note.—The starch "lumps", and the smooth jelly is not made. If one of the lumps is broken open the interior is seen to contain small hard grains of starch.

Starch consists of very small grains, which swell and take up water when the conditions are suitable. When the starch paste meets boiling water, each grain can swell and burst. If the boiling water be added to the dry starch, some of the grains swell very quickly, but others are protected by the swollen grains and cannot be acted upon.

Experiments.—1. Show starch grains under the microscope.

2. Show a little starch jelly under the microscope.

3. Test several foods, rice, cornflour, tapioca, semolina, arrowroot, flour, for starch.

METHOD OF COOKING STARCHY FOODS

All the above-mentioned starchy foods require to be cooked before being eaten. The methods of cooking must be such that the grains can swell equally and sufficiently.

Experiments.—1. Pour boiling water or milk on cornflour.

2. Take a dessertspoonful of cornflour, mix to a smooth paste with a little cold milk or water, add ½ pt. of hot milk; heat slowly to boiling, stirring all the time.

3. Boil some water in an enamel pan; tie some rice in a cloth tightly, boil for about twenty minutes, and then examine the grains.

Note.—The grains are unable to swell, and remain hard.

4. Repeat experiment, with rice tied loosely in a cloth.

Note.—The grains are found to be soft.

5. Boil about ½ pt. of water in an enamel pan. Weigh accurately about 14 g. of rice. Drop the rice slowly into the water; boil for about twenty minutes, stirring all the time. When the grains are soft, filter, dry between filter paper, and weigh the rice.

Note.—In the process of cooking the starch grains have absorbed water, consequently there is a gain in weight.

EFFECT OF HEAT ON SUGAR AND WATER AT DIFFERENT TEMPERATURES

Experiment.—Dissolve 26 g. of white sugar in 10 cu. cm. of water. Bring to boiling-point and boil for a few minutes. The temperature rises to 101° C. Dip the tip of the forefinger into the syrup.

Note.—If the forefinger is touched with the thumb, the sugar can be drawn out into a little thread about 2 mm. long.

Experiment.—Continue to heat the syrup until the temperature rises to 105° C. Again dip in the forefinger.

Note.—The thread can be pulled out to a considerable length.

Experiment.—Again heat the syrup and let the temperature rise to 143° C. Dip in a glass rod, and then dip the rod into cold water.

Note.—The sugar breaks with a slight crack and would stick to the teeth.

Experiment.—Heat the syrup until the temperature rises to 155° C. Again dip in a glass rod and dip into water.

Note.—The sugar breaks with a louder crack and is very brittle. It would not stick to the teeth.

Experiment.—Continue to heat the sugar.

Note.—The syrup turns yellow; this is the "caramel" stage. If the heating be continued the sugar burns.

The difference in the consistency of the sugar-and-water mixture at different temperatures enables various kinds of sweets to be made.

To make Sugar Twist.—Weigh out 56 g. of white sugar, dissolve in 20 cu. cm. of water, heat to 143° C. Then pour on to a greased tile. As the edges cool, fold them over. When the sugar is sufficiently cool, pull out several times and twist.

Note.—A white satiny-looking twist is formed. If the syrup is pulled when too hot, it is apt to crystallize and go back to ordinary sugar.

To make Sugar Cream.—Weigh out 50 g. of white sugar and 2 g. of glucose. Dissolve in 15 cu. cm. of water, and heat quickly to 115° C. Pour on to a wetted tile, let it cool slightly, and then work well with a glass rod.

Note.—A stiff opaque mass is formed, which can be rolled with the hands into any shape or cut with a knife.

CHANGING STARCH TO SUGAR

One of the common phenomena of plant life is the conversion of starch to sugar. Chemists have found that the change can be effected in a laboratory by the action of heat, water and acid.

Experiment.—Take as much starch as would cover a shilling, half-fill a medium-size beaker with water, put in the starch and a few drops of strong hydrochloric acid, and boil.

After half an hour test the liquid with iodine. When the solution no longer changes iodine, test for grape sugar.

Note.—At first the solution is cloudy; after a short time it becomes clear. The starch changes to sugar in about three-quarters of an hour.

COMPOSITION

Starch, cane sugar and grape sugar have been found to consist of three elements—carbon, hydrogen and oxygen. The hydrogen and oxygen are in the right proportion to form water. For this reason the substances are called carbohydrates. The starch contains least water in proportion to the carbon, and the cane sugar the next. When starch and cane sugar are changed into grape sugar they absorb water. The process is called "hydration".

FERMENTATION

The cause of fermentation is very small unicellular plants called "yeast", which float in the air and are invisible to the naked eye. When these cells have the food and warmth and moisture necessary, they grow and make new yeast plants.

Jam ferments best at a temperature of about 25° C. (77° F.). The fermentation is stopped if it is reboiled and more sugar added. The yeast plants are killed by exposure to a too high temperature, and they do not grow well if the sugar solution is too strong. If we wish to study fermentation, the action can be much hastened by the *addition* of yeast.

Experiment.—Take about three tablespoonfuls of jam or marmalade in a flask, add about 100 cu. cm. of hot water; pour off from the fruit skins and let cool to a temperature of 25° C.; when cool add a little yeast. Do a similar experiment with 20 g. of grape sugar dissolved in 100 cu. cm. of water.

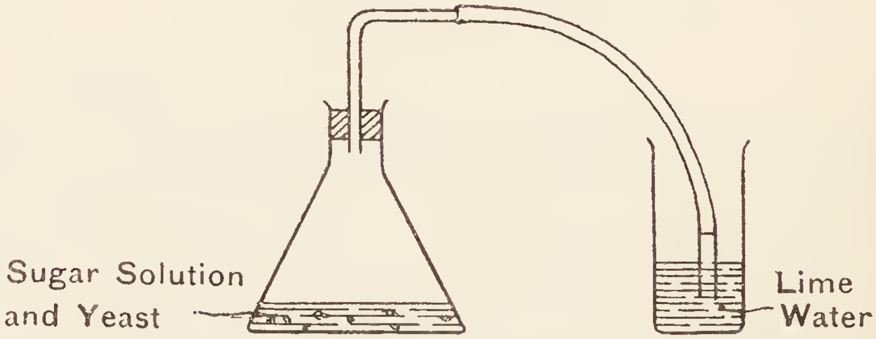

Fig. 1.—Diagram of Apparatus for showing that Carbon Dioxide is given off during Fermentation

Note.—In about thirty minutes the solution begins to bubble. Put a cork in the neck provided with a delivery tube and pass the gas into lime water. Then leave the liquid standing. In a few minutes the lime water turns milky.

Leave the experiment for a few days. The yeast has increased in bulk; it is no longer in small lumps but covers the bottom of the flask. The liquid has lost its sweet taste and there is a smell of spirit. The lime water sometimes is very cloudy, sometimes quite clear; in this latter case it becomes cloudy on boiling.

Experiment.—Pour the liquid away from the yeast into a clean dry flask. Connect up with a condenser. Put a thermometer into the flask and heat gently.

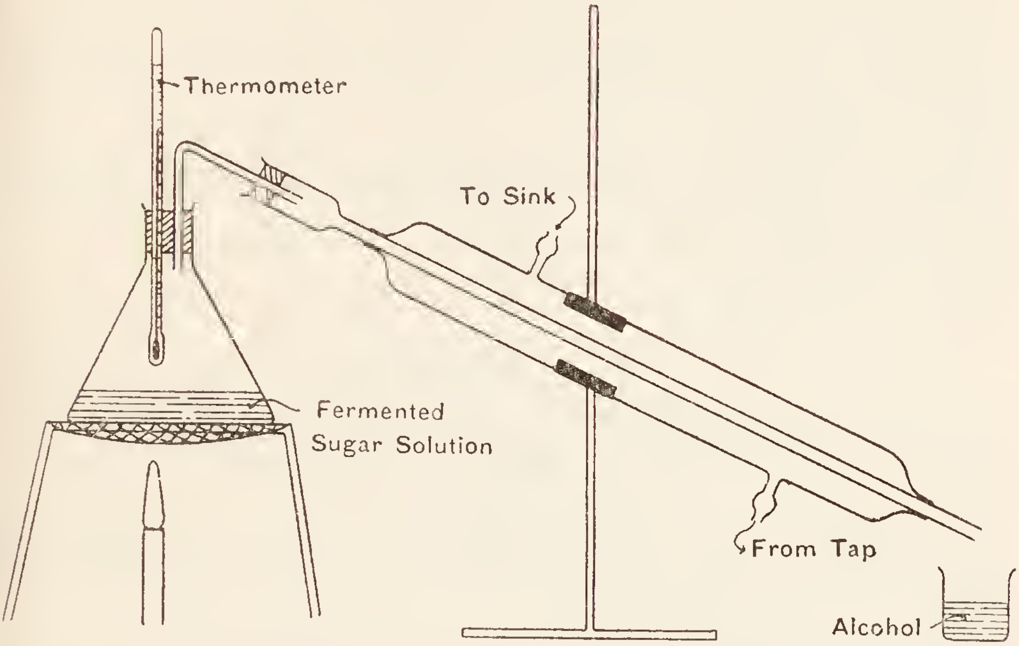

Fig. 2.—Diagram of Apparatus used to obtain Alcohol from Fermented Sugar Solution

Note.—A liquid begins to boil and distil over at 77° C.; the temperature rises rapidly to 94° C. or 95° C. and then is stationary.

When the thermometer begins to rise again, change the receiving flask. The thermometer generally rises to 99° C. or 100° C.

The fractions have a spirity taste and smell.

Experiment.—Put a lighted match to the first.

Note.—Sometimes the liquid burns; if not, heat until boiling, then light.

Note.—The liquid burns for a time and then goes out.

The second fraction does not burn without being heated, and then not for long.

The liquid that distils over is a mixture of alcohol and water; the first fraction contains more alcohol.

The heating can be continued until pure water comes over.

CHAPTER II

FATS AND OILS

Examine the appearance of suet, dripping, butter, lard and oil.

All the fats and oils have the characteristic greasy feeling. They differ in degrees of hardness, some being hard solids like suet, others liquid like oil. Butter, lard, and dripping are intermediate substances.

Experiment.—Put a small portion of each fat into a test tube half-full of cold water. Heat the water to boiling.

Note.—No fats mix with water. The liquid fat is lighter than water. Although the water is heated to boiling, the fat undergoes no change after melting.

Experiment.—Heat a small portion of each substance on a crucible lid.

Note.—When heated, the solid fats melt, a fizzling noise is heard caused by the water escaping. After a short time the bubbling ceases and the liquid fat is still. Blue smoke arises, strong-smelling fumes are given off having an acid reaction to litmus paper, and the fat chars and catches fire. The carbon burns away at red heat.

Oils and fats have *no* boiling-point. The fumes that come off are acid fumes and are caused by the decomposition of the substance. The temperature of frying is the highest temperature to which the fat or oil can be raised without decomposition.

Fats and oils contain the three elements carbon, hydrogen and oxygen, but the hydrogen and the oxygen are *not* in the proportion to form water.

Fats and oils are soluble in liquids such as ether, alcohol and benzene. As ether and benzene are very inflammable, they should never be brought near a flame, and as some people cannot stand the smell, ether experiments are best carried out by an open window.

Experiment.—Put a little fat or oil in a test tube. Half-fill with ether and shake up. Then pour off the top layer (which is ether) into a glass dish and leave to evaporate outside a window.

Note.—In a few minutes the ether has evaporated and the fat or oil is left.

Experiment.—Heat some fat in a porcelain basin until it bubbles, put in about a cubic inch of bread, and leave it in for about two minutes.

Then continue heating the fat until it smokes. Put in a second cube of bread the same size as the first, and leave it in for the same time.

Note.—The first cube is found to be light in colour and the grease has soaked into it. The second is brown and crisp and only greasy on the outside.

Experiment.—Put a little washing soda into each greasy test tube. Half-fill with water, and heat to boiling.

Note.—The grease gradually disappears and a soapy lather is seen in the test tube.

Experiment.—Put a little caustic soda solution into a greasy test tube, and heat. Do a similar experiment using caustic potash solution.

The action of the alkalis on fats is to dissolve them, but at the same time the fats are changed and a soap lather is formed.

SOAP MAKING

It is a good plan to make different soaps in the class:—

Soap from caustic potash and oil.
,, ,, caustic soda and oil.
,, ,, caustic potash and suet, &c.

The caustic alkalis are better for the purpose than washing soda.

Experiment.— Take a medium-sized beaker half-full of strong caustic potash or soda solution. Cut up a piece of suet about as large as a nut into small pieces, take off the skin, put into the alkaline solution, and boil. The mixture is very apt to bump.[1] To prevent this, put in small pieces of broken pot and stir the mixture. If oil be used, take about 15 cu. cm. Boil the mixture for about two hours, adding water and alkali if necessary.

Note.—A soft solid separates out on cooling. This rises to the top; the liquid is left below. Sometimes the whole contents of the beaker solidify.

Experiment.—Take a little of the solid and add water. If it is soluble, making a soap lather, the fat has been changed to soap. If practically no soap has been made, the mixture must be reboiled with more alkali.

Dissolve the soap in water. Add a large quantity of salt. The soap separates out on the top of the liquid. Skim off, and leave to dry.

Soap prepared in the laboratory in this manner is found to be very alkaline and good for washing up dirty apparatus. In the ordinary process of soap making, fats are boiled with caustic soda and then salted out. The soap sets and makes hard soap. Soft soap is made by boiling fats with caustic potash, but if this were salted out some of it would be changed to hard soap.

---

[1] Strong alkaline solutions are apt to boil unevenly. The boiling ceases for several seconds, then a large volume of steam is suddenly formed and the liquid is thrown violently upwards in the vessel. This phenomenon is called "bumping".

PROPERTIES OF SOAP

Examine specimens of curd soap, yellow soap, primrose soap, Sunlight, &c.

Experiment.—Dissolve a little of each soap in water. Test with litmus.

Note.—The characteristic lather is found; the strength of the alkaline reaction varies.

Experiment.—Add a little dilute acid to a soap solution.

Note.—A white precipitate is formed, and the liquid no longer has the power to make a lather.

Experiment.—Shake up a few shreds of soap with methylated spirit. Warm gently by putting the test tube into warm water.

Note.—The soap dissolves, but no lather is formed.

Experiment.—Shred up some soaps. Weigh a crucible, put in .4 g. to 1 g. of soap. Heat in the air oven to a temperature just over 100° C. for about two hours, let cool, and weigh again.

Note. — Different soaps contain different amounts of water: yellow soap, about 22 per cent; soft soap, about 43 per cent; curd soap, about 10 per cent. These results will vary with the time the soaps have been kept.

Experiment.—Dissolve 3 g. of various soaps in about 80 cu. cm. of water. Warm until all the soap is dissolved. Add excess of salt. The soap separates out, the alkali remains in solution. Filter. Wash the precipitate with water to wash off any alkali. Neutralize the filtrate with very weak hydrochloric acid, 1 part acid to 200 parts water. Compare the amounts of acid required.

Note.—Curd soap contains very little alkali. Soft soap contains a large amount of free alkali.

HUDSON'S SOAP

Experiment.—Dissolve a little Hudson's soap in water. Test with litmus.

Note.—The solution is strongly alkaline.

Experiment.—Pour a little weak hydrochloric acid on the powder.

Note.—There is a strong effervescence, and the gas is found to be carbon dioxide.

The experiments suggest that the powder is a mixture of soap and soda. If this is so, the two substances can be separated.

Experiment.—Mix a little washing soda with methylated spirit and warm gently.

Note.—The soda is insoluble.

Experiment. — Warm a little of the soap powder in a test tube with methylated spirit. Pour off the spirit, and repeat the process several times. Dissolve the residue in water; add a little litmus solution. Neutralize with weak hydrochloric acid, and evaporate down.

Note.—Salt is left. The alkali was therefore soda.

HARD AND SOFT WATER

Water in which soap lathers easily is called "soft", water in which it lathers with difficulty is called "hard". The harder the water, therefore, the greater the amount of soap needed to make a lather.

Experiments.—1. Shred up and weigh 10 g. of curd or Castile soap. Take a few shreds in a test tube. Half-fill with methylated spirit and warm gently. The soap dissolves slowly. Pour the solution into a litre flask, and add more cold spirit to prevent the soap separating out from solution on cooling. Continue the experiment until all the soap has been dissolved. Then add spirit until the solution measures 1000 cu. cm.

2. Fill a burette with the soap solution. Put 50 cu. cm. distilled water into a stoppered bottle. Add the soap solution ½ cu. cm. at a time, shaking up after each addition. See how many cubic centimetres are needed to make a lather that lasts for three minutes.

3. Do a similar experiment, using the water of the district.

Note.—It is a good plan to be provided with some water that has chalk dissolved in it, as, for example, the North Kent water, and some with calcium sulphate dissolved in it.

4. Find out how much soap solution is needed

to make a lather with 50 cu. cm. of chalk water and calcium sulphate water.

Note.—The soap is very apt to curdle if there is much calcium sulphate present.

The chalk water and calcium sulphate water need much more soap to make a lather than the distilled water.

METHODS OF SOFTENING WATER

Hard water is very inconvenient for household use on account of the amount of soap wasted. There are various methods of softening. As it is the dissolved solids that cause the hardness, if these can be removed the water will be softened.

Experiment.—Boil some chalk water over the Bunsen burner for about five minutes. The water becomes cloudy. Filter and test the hardness. The water will be considerably softened.

Water that can be softened by boiling is called "temporarily" hard.

Experiments.—1. Add a little washing soda to some chalk water. Filter off the cloudy solid and again test the hardness.

2. Shake up some chalk water with powdered borax. Warm, filter, and again test.

3. Do a similar experiment, adding ammonia to the chalk water.

Soda, ammonia, and borax are found to soften the water.

Experiment. — Boil some calcium sulphate water for about five minutes. Filter if any cloudiness forms and again test the hardness.

Note.—There is practically no difference in the amount of soap needed.

Water that cannot be softened by boiling is called "permanently" hard.

Experiment. — Try whether washing soda, ammonia, and borax will soften calcium sulphate water.

Note.—The best softener for permanently hard water is soda.

CHAPTER III

PROTEIDS

Proteids or nitrogenous food substances contain the elements carbon, hydrogen, oxygen, nitrogen and a little sulphur. One of the best examples to study is the white of egg, which consists of albumen and water.

Experiment.—Break some eggs, separate the yolks from the whites. Examine the appearance and feeling of the white.

Note.—If quite fresh, the albumen has no smell or taste. It feels very sticky and has a slightly alkaline reaction to litmus paper. It cannot be divided easily unless cut with scissors.

Experiment.—Heat a little white on a crucible lid.

Note.—The white coagulates, forming a white solid, which quickly begins to decompose. Steam is given off. There is a disagreeable smell of burning bones, and alkaline fumes are given off. The carbon burns away at red heat, leaving practically nothing behind. The alkaline fumes show the formation of ammonia, which consists of the elements nitrogen and hydrogen. The action of heat on all nitrogenous food substances is the formation of ammonia.

Experiment.—Mix a little of the albumen with cold water and then heat.

Note.—If quite fresh, the albumen dissolves. Very often the liquid is cloudy. In this case filter a little and prove the presence of albumen in the filtrate by evaporating down. As the water is heated it becomes cloudy and then an opaque solid separates out.

Experiment. — Put a little albumen into a test tube; put in a thermometer. Put the test tube into a beaker of water, and heat the beaker.

Note. — After a time the albumen becomes cloudy and then coagu-

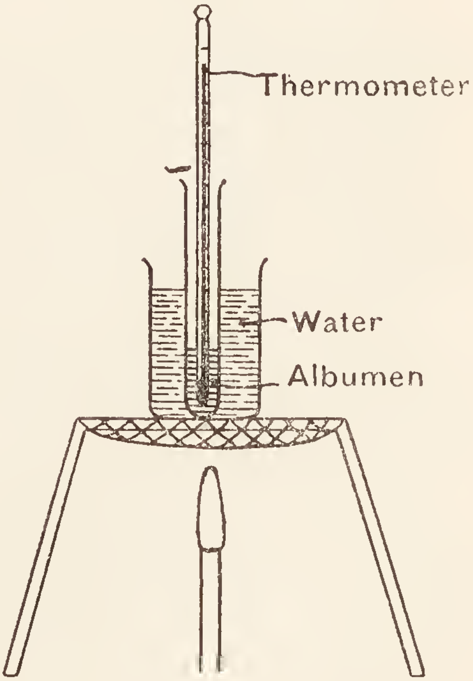

Fig. 3.—Diagram of Apparatus used to find Coagulation Temperature of Albumen

lates. If the egg is quite fresh the coagulation temperature is about 64° C. When the eggs are not so fresh the coagulation temperature is variable.

Experiment.—Find the coagulation temperature of dissolved albumen.

Note.—The same result is obtained as in the preceding experiment.

Experiment.—Put a little albumen into three test tubes. Add dilute hydrochloric acid to one, dilute sulphuric to another, and dilute nitric to the third.

Note.—In each case the albumen coagulates.

Experiment.—Try the effect of cold alkaline solutions on albumen.

Note.—There is no coagulation.

Experiment.—Try the effect of salt solutions on albumen.

Note.—The results vary; copper sulphate causes coagulation, zinc sulphate also, sodium chloride solution has no action.

Experiment.—Try the effect of alcohol and strong tea, respectively, on albumen. Coagulation results.

The characteristic property of albumen is its power of coagulation. This is effected by heat and by many substances.

METHODS OF COOKING

Experiments.—1. Heat some water to boiling. Put in the egg. Take the pan away from the gas. Cover it up and leave the egg in the water for eight minutes.

2. Boil some water in a pan; put in the egg. Let it boil for four minutes, then take it out. Examine both the eggs.

Note.—The white of the egg cooked as in Experiment 1 is a soft solid; the yolk is a stiff jelly.

The egg of Experiment 2 is much more unevenly cooked: the white is comparatively hard, the yolk is quite liquid.

RELATIVE DIGESTIBILITY

The digestion of the albumen begins in the stomach with the action of the gastric juice. The two important constituents which dissolve albumen are pepsin and hydrochloric acid. For the following experiment pepsin tablets (2 gr. to a tablet) may be used.

Experiments.—1. Pound in a pestle and mortar four pepsin tablets, mix with 50 cu. cm. of water and 2 cu. cm. of strong hydrochloric acid, and warm to 30° C. This mixture practically forms artificial gastric juice.

2. Half-fill three test tubes with the mixture. Into *a* put a small piece of "cooked" white of egg; into *b* the same size piece of "boiled"

white; into *c* a piece of "boiled" white very finely chopped. Put the test tubes in a beaker of water kept at 36° C. and stir contents of the test tubes.

Note.—In about twenty minutes the albumen shows signs of dissolving. Solution in *a* goes on more quickly than in *b*. At the end of one and a half to two hours the albumen in *a* has practically disappeared, that in *b* is somewhat smaller, and the pieces in *c* are considerably diminished in size.

The experiment shows that the soft-cooked white is more digestible than the boiled; it also brings out the importance of properly masticating food.

The first stage in the digestion of a proteid is solution. When thus dissolved it is called a peptone.

TEST FOR PROTEIDS

3. Take a little egg albumen in a test tube; add one drop of copper sulphate solution from a glass rod, and a few drops of strong caustic potash or soda solution.

Note.—A violet coloration results.

TEST FOR PEPTONES

4. Beat up a little raw white of egg and put it into a test tube half-full of artificial gastric juice, and leave for about half an hour in a water bath of temperature 36° C.

Test the solution with one drop of copper sulphate and a few drops of strong potash.

Note.—A red coloration (claret or dull rose colour) results. The proteid has been changed to peptone.

5. Test the liquids of Experiment 2 with copper sulphate and potash at varying intervals.

Note. — Different colorations are produced, showing the gradual conversion of the proteid to peptone.

EXAMINATION OF EGG SHELL

Experiment.—Take off the skin from the shell as far as possible, and heat a little on a crucible lid.

Note.—There is slight charring, but the shell is seen to consist mainly of mineral matter.

Experiment.—Put a little egg shell into a test tube, add dilute hydrochloric acid, and warm gently.

Note.—A gas is given off which proves to be carbon dioxide.

Experiment.—Pour off a little of the clear liquid when effervescence has ceased, and evaporate down in the fume cupboard.

Note.—A white solid is left which absorbs moisture from the air. This is characteristic of calcium chloride, and further experiments prove it to be this substance.

TESTS FOR FRESHNESS OF EGGS

A fresh egg held up to the gas in a gaslit room appears translucent; when stale it is cloudy. The freshness can also be tested by shaking. In a new-laid egg the contents do not move when the egg is shaken.

When the egg is kept, the water of the white slowly evaporates through the porous shell; air at the same time enters the egg. The evaporation of the water causes the clouding of the albumen, and also makes the egg lighter; consequently a fresh egg sinks in water while a stale egg floats.

AMOUNT OF WATER IN WHITE OF EGG

The boiling-point of water is 100° C. If white of egg is kept at this temperature for some time, the water will evaporate and the albumen will be left.

Experiment.—Weigh a crucible. Weigh the crucible with a little white of egg in it. Heat in an air oven kept at a temperature of 100° C. until the water has evaporated and the weight is constant.

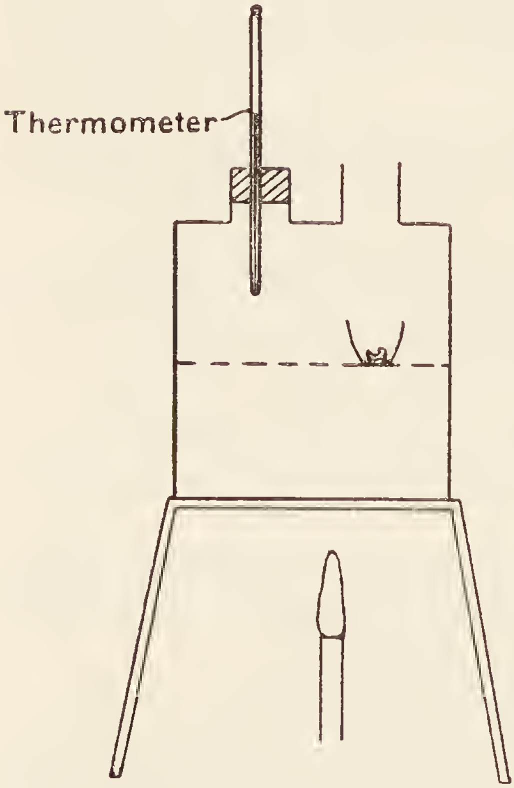

Fig. 4.—Diagram of an Air Oven

Note.—Egg white is found to contain about 85 per cent of water.

EXAMINATION OF LEAN MEAT

Experiment.—Heat a small piece of lean meat on a crucible lid.

Note.—The meat cooks and turns brown, then begins to char. Ammonia fumes are given off, later on possibly some acid fumes. The carbon burns away at red heat, leaving a little mineral ash. Meat, therefore, is a nitrogenous food substance.

Experiment.—Cut up some small pieces of meat and leave them in cold water.

Note.—The water changes colour; it is evident that something is dissolving out of the meat. It is possible that albumen may be present.

Experiment.—Cut up some meat into small pieces. Cover with cold water. Put them into a wide test tube, and put in a thermometer. Put the test tube into a beaker of water, and keep the temperature at 60° C. for one and a half or two hours.

Note. — The water becomes red, then pale brown, and small pieces of solid float about. If the experiment be continued long enough the liquid becomes a rich red-brown colour, while the pieces of meat are almost white.

Experiment.—Filter the liquid and heat a little of the clear reddish-brown solution.

Note.—When a certain temperature is reached the liquid suddenly becomes opaque. This change indicates the presence of albumen in the solution.

Experiment.—Find the coagulation temperature in the same way in which that of egg albumen was found.

Note. — The temperature is about 64° C.–68° C.

Experiment.—Test the clear liquid with a little dilute acid.

Note.—Slight coagulation results.

One of the most important constituents of lean meat is albumen, which can be gradually dissolved out by warm water.

Experiment.—Heat on a crucible lid a little piece of the white meat left in the test tube.

Note.—A large quantity of ammonia fumes is given off, showing that by no means all the proteid matter has been extracted.

If this proteid is to be of service as food it must be capable of being changed by the gastric juice into peptone.

Experiment.—Put some artificial gastric juice (prepared as in former experiments) into a test tube; put in small pieces of the cooked meat. Keep at a temperature of 36° C. for about half an hour. Then test for peptones.

Note.—The test is generally successful after about three-quarters of an hour to an hour.

"Soup" meat, as it is commonly called, contains a considerable quantity of proteid matter, and if properly served can be used for food.

Experiment.—Put a small piece of meat into boiling water. Boil for about ten minutes or quarter of an hour.

Note.—The meat is found to be very tough. There is hardly any change in the water except that there is a little scum on the surface.

Experiment.—Collect a little of the scum and heat on a crucible lid.

Note.—It is found to be proteid matter.

When meat is put into boiling water the albumen is coagulated, and very little soluble matter is able to come out. It is impossible to make meat broth by this method. At the same time the meat is too hard to be easily digested.

Experiment.—Put a little meat into boiling water; take away the flame. Keep the water at 80° C. for ten minutes or quarter of an hour.

Note.—The albumen has been coagulated by the boiling water, but the meat has not been hardened by exposure to a too high temperature.

Experiment.—Compare the digestibilities of a piece of "boiled" meat and a piece of "simmered" meat in the same way that those of egg albumen were compared.

Summary.—The chief constituent of lean meat is proteid matter.

FISH

Cod or fresh haddock are good examples to study.

Experiment.—Heat a little haddock on a crucible lid.

Note.—Water is given off, then a large quantity of ammonia fumes, showing that the fish consists chiefly of proteid matter. Mineral ash is left.

Experiment.—Put some small pieces of fish into a test tube, cover with cold water, and put in a thermometer. Put the test tube into a beaker of water. Keep the fish at 60° C. for about one and a half hours. Then filter a little of the liquid. Test for albumen.

Note.—The liquid becomes opaque on heating, and if the coagulation temperature be taken it is found to be about 64° to 68° C.

Slight coagulation results when dilute acid is added.

Experiment.—Cook a little fish by putting into water that is on the point of boiling—that is, at 95° or 97° C. Let the temperature fall to 80° C., and simmer until the fish is cooked.

Fry a little fish. Melt some fat in a porcelain basin, heat until the blue smoke arises, then put in the fish.

Take a simmered piece and a fried piece of exactly the same size, and test their relative digestibilities with the artificial gastric juice.

CHAPTER IV

FOOD CONTAINING PROTEID AND FAT

EXAMINATION OF THE YOLK OF EGG

Experiment.—Examine the appearance of the yolk.

Note.—Egg yolk is an opaque yellow liquid which feels greasy and leaves a greasy stain.

Experiment.—Heat a little egg yolk on a crucible lid.

Note.—The yolk coagulates; steam is given off, there is a disagreeable smell as the yolk begins to decompose. Ammonia fumes are given off; the substance has then the appearance of decomposing fat. Acid fumes are given off; the carbon burns away at red heat, leaving a trace of mineral ash.

Experiment.—Take the coagulation temperature in the same way as that of white of egg was taken.

Note.—The coagulation temperature is higher than that of the white.

Experiment.—Mix some egg yolk with cold water and then heat.

Note.—The yolk coagulates on heating and separates out.

Experiment.—Try the effect of dilute acids and salt solutions on yolk of egg.

Note.—The yolk coagulates with acids. The effect is not so marked with salts.

Experiment.—Try the effect of caustic soda and potash solutions on egg yolk.

Note.—The yolk becomes much stiffer, as if part of it were coagulating.

Experiment.—Warm the test tube.

Note.—Part of the yolk coagulates, the alkaline liquid becomes yellow in colour, froths up very much, making a soapy solution.

TO OBTAIN THE FAT

From the fact that egg yolk leaves a greasy stain and makes a soapy solution with caustic potash it is obvious that fat is present. Fats dissolve in liquids such as ether, alcohol, benzine, &c. The fat of egg yolk can best be obtained by using ether. As this liquid is very inflammable it must never be taken near a flame, and as some people cannot bear the smell, the experiment is most safely carried out by an open window.

Experiment.—Take a test tube containing a little egg yolk, add some ether, and shake up. Leave the test tube standing outside the window.

Note.—In a few minutes two layers will have formed in the tube, and the ether layer is at the top. Pour this off into a glass dish, and leave the dish in the open air for about ten minutes. The ether is found to have evaporated, and yellowish-white soft fat is left in the dish.

THE PREPARATION OF EGG SOAP

Experiment.—Take a beaker half-full of caustic potash or caustic soda solution, add some yolk of egg. Heat carefully, as the liquid froths up considerably and is apt to boil over. Take out the pieces of coagulated solid, and continue the boiling for about twenty minutes.

Note.—The liquid often sets to a soft yellow jelly on cooling.

Experiment.—Put a little of the jelly into water and heat.

Note.—If the soap has been properly made it will completely dissolve in the water, forming a yellow soapy solution.

Experiment.—Dissolve the whole of the soap in water, and add salt.

Note.—The soap separates out in the usual way, being insoluble in salt water.

Summary.—The yolk of the egg consists of proteid substance, fat and water.

The amount of water in the yolk of egg can be found in the same way as the amount of water in the white was determined. (See p. 34.)

HERRING

If the experiments that are done with cod or haddock are worked through with herring, fat and proteid are obtained. When the herring is heated, the fat oozes out and makes a translucent mark on white paper. The proteid can be extracted with warm water. The fat can be dissolved in ether.

The chief difference in the various kinds of fish is the relative amounts of proteid and fat. The less fat there is in the fish the more digestible the fish as a rule.

Chapter V

MORE COMPLEX FOODS

MILK

Notice the taste, smell, and appearance of ordinary fresh milk. Put in some litmus paper.

Note.—There is generally a slightly alkaline reaction.

Experiment.—Put a small quantity of milk into a crucible and heat gently over the Bunsen burner.

Note.—The milk steams and a skin is formed on the surface. It expands considerably when it boils, bubbling up to the top of the crucible. It gradually dries up to a solid, then turns brown and gives off alkaline fumes. At a later stage acid fumes are given off. The milk catches fire and burns to a black solid. The carbon roasts away at red heat, leaving a white mineral ash.

The alkaline fumes suggest the presence of proteid, and the acid fumes in the later stages the presence of fat. The water and mineral matter are clearly seen. The formation of the skin suggests that albumen may be present.

Experiment.—Put some milk into a beaker, put the beaker inside a larger one containing water. Heat and take the temperature at which the skin forms.

Note.—A complete skin has formed at 68° C.

Experiment.—Heat the skin.

Note.—Ammonia fumes are given off, showing that the skin is proteid matter.

An interesting experiment is to keep a small beaker of milk at a temperature of 68° C., and see how many skins are formed.

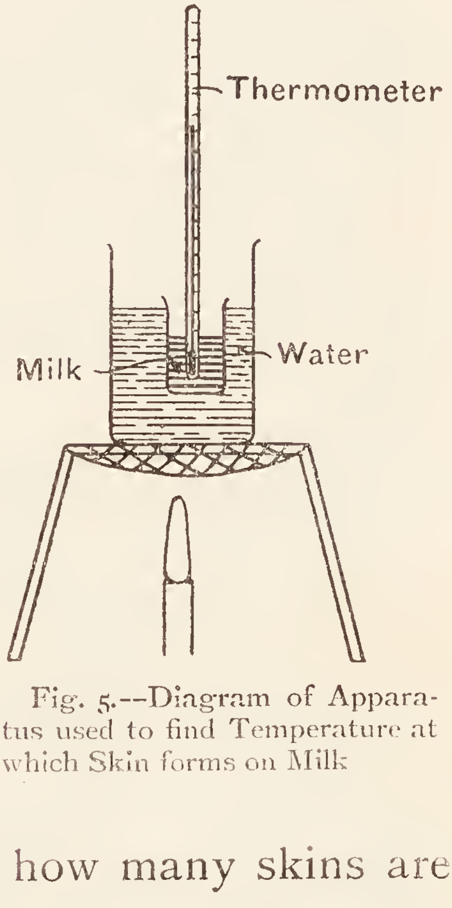

Fig. 5.—Diagram of Apparatus used to find Temperature at which Skin forms on Milk

Milk can often be heated to boiling-point in a test tube without a skin forming.

For a skin to form, it is necessary that a considerable surface of the milk be exposed to the air.

Experiment.—Test some milk with dilute acids.

Note.—A solid forms.

Experiment.—Filter off the solid. Wash with warm water until the liquid no longer has an acid reaction. Heat the solid on a crucible lid.

Note.—Ammonia fumes are given off, showing that the solid is proteid substance.

Milk contains two proteids: one is called milk albumen, the other is casein.

When milk is spilt it leaves a greasy stain. This suggests the presence of fat.

Experiment.—Take a little milk in a test tube. Add about twice the volume of ether. Shake up, pour off the ether layer, and leave to evaporate.

Note.—Fat is present.

When milk is left to stand for some hours a thick layer of cream forms on the surface. If this be tested with ether it is found to consist very largely of fat.

The sweet taste of milk suggests the presence of sugar.

Experiment.—Test milk with copper sulphate and caustic potash solutions.

Note.—Before the test tube is warmed, the purple colour characteristic of proteid is seen; when warmed, a good sugar reaction is obtained.

The sugar belongs to the same class as grape sugar. It is one of the less-sweet sugars and is called milk sugar.

Experiment.—Test some milk with iodine solution. There is no sign of starch.

AMOUNT OF WATER IN MILK

The boiling-point of water is 100° C. If milk is kept at this temperature for some time the water will boil away and the solids will be left.

Experiment.—Weigh a crucible. Put in milk until the crucible is about one-quarter full. Weigh the crucible and milk. Heat in an air oven until the milk has become solid and the weight is constant. The temperature of the oven must be kept at 100° C. See fig. 4, p. 34.

Note.—Milk is found to contain 87 per cent water.

By this method it is easy to find whether the milk has been watered by the milkman.

PERCENTAGE OF MINERAL MATTER

Experiment.—Weigh a crucible. Weigh the crucible half-full of milk. Heat carefully until all the water has evaporated. Then ignite strongly until ash only is left. Weigh again.

Note.—The percentage is about .9.

SPECIFIC GRAVITY OF MILK

By the term specific gravity we mean the weight of some milk compared with the weight of an equal volume of water.

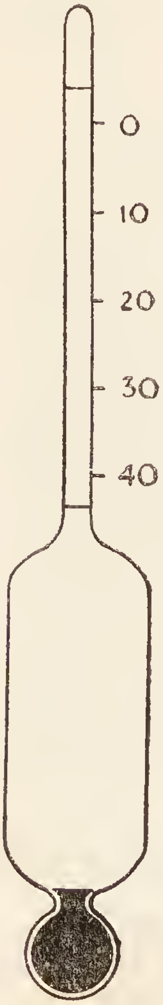

Fig. 6.—Diagram of Lactometer

Experiment.—Weigh a small stoppered bottle. Weigh the bottle full of milk. Weigh the same bottle full of water. Divide the weight of the milk by the weight of the water.

Note.—Numbers varying from 1.028 to 1.034 are obtained.

The lactometer is an instrument for measuring the specific gravity of milk. It is a hydrometer the scale readings of which extend from 1–1.040. When put into milk the hydrometer reads from 1.028 to 1.034.

Experiment.—Put a hydrometer into milk and take the reading. Then take 100 cu. cm. milk, add 20 cu. cm. water, and again read the specific gravity.

Note.—If the answer 1.034 were first obtained, the specific gravity is now found to be 1.028. The specific gravity is lowered by the addition of water.

The weight of 100 cu. cm. milk = 103.4 g.
” 20 ” water = 20 ”

∴ 120 cu. cm. milk and water
weigh ... ... 123.4 g. as
there is no volume change on mixing.

∴ 1 cu. cm. liquid weighs $\frac{123.4}{120} = 1.028.$

Experiment. — Take the specific gravity of some milk. Leave it to stand for several hours until a thick layer of cream has risen. Take off the cream, then find the specific gravity of the skim milk.

Note. — Skim milk has a higher specific gravity than whole milk.

Cream, being a fat, is lighter than water. Consequently, when the cream has been removed and the specific gravity of the milk thus increased, it is possible to add water in such a quantity that the specific gravity of the mixture is the same as that of whole milk. We cannot detect the twofold adulteration by the lactometer, and the only simple method of doing so is by the estimation of the water as described on page 46.

Summary. — Milk contains water, proteid, sugar, fat and mineral matter.

As it contains representatives of every class of food substances, milk is often said to be a perfect food. The term, however, is not strictly exact, as the proportion of water is too large, thus causing the milk to be a very bulky foodstuff.

THE MAKING OF JUNKET

Milk can be made solid by the action of rennet (a substance prepared from the stomach of a calf; rennet can also be prepared from gastric juice).

Experiment.—Take about 300 cu. cm. of milk, warm it to 36° C., add a small teaspoonful of essence of rennet, stir, and leave to stand in a cool place.

Note.—In about half an hour the milk has changed to a thick jelly. If this is put on a filter paper in a funnel a liquid slowly trickles through.

Experiment.—Heat some of the solid on a crucible lid.

Note.—Ammonia fumes are given off, showing the solid to contain proteid matter.

Experiment.—Shake up the solid with ether; pour off the ether layer and leave to evaporate.

Note.—Fat is found to be present.

THE SOURING OF MILK

Experiment.—Leave some milk in a basin for twenty-four or thirty-six hours.

Note.—The milk has a characteristic smell, a solid substance is separating out and there is a layer of cream on the surface. If the liquid be tested with litmus paper it is found to have a strongly acid reaction.

Experiment.—Filter off a little of the solid, wash with warm water until the washings no longer have an acid reaction, and heat on a crucible lid.

Note.—Ammonia fumes are given off, showing that the solid consists largely of proteid matter.

The proteid is made insoluble by the formation of free acid in the milk.

If the milk is left for about three days it separates into "curds" and "whey". The curd consists of proteid, some fat, and mineral substance; the whey has an acid reaction, contains sugar, mineral matter and water.

CONDENSED AND SOLID MILK

It is interesting to work through the milk experiments with unsweetened condensed and with solid milk, and to compare the results.

The Viking unsweetened condensed, and the Cow and Gate brand solid milk, are good substances to work with. In using Viking milk, 100 cu. cm. of milk added to 250 cu. cm. of water gives a mixture containing about the same percentage of water as cows' milk. The proteid of the solution is precipitated by dilute acids and by copper sulphate solution, the fat is extracted with ether, and a good sugar reaction is obtained. Viking condensed milk does not make junket with rennet.

METHODS OF PRESERVING MILK

It is commonly known that milk which has not been heated goes sour much more quickly than milk which has. The most usual practice is to boil or scald the milk, but this process considerably alters the taste. Another method is to "pasteurize" the milk.

Experiment.—To "pasteurize" milk: Take a beaker of milk, put it in a larger vessel of water and heat till the milk has a temperature of 55° C. See fig. 5. Keep the milk between 55° C. and 70° C. for half an hour, and then cool it quickly by holding the beaker under the cold-water tap.

Note.—This milk has not the taste of boiled milk.

Experiment.—Take three beakers; into one put fresh milk, into the second pasteurized milk, into the third milk that has been heated to boiling-point and then left to cool. Leave these in a cool, airy place.

Note.—After twenty-four or thirty-six hours the fresh milk is sour, the other two are quite sweet.

Pasteurized milk should not be kept more than one or two days, as decomposition changes take place.

CHEESE

Cheese is made from milk by treating it with rennet or with a weak acid such as vinegar. The milk may also be left to turn sour. If acid be used, the solid only contains a small quantity of fat, and the cheese is said to be "lean". If rennet be used, the solid contains more fat. The solid is pressed to squeeze out the whey, and according to the amount of pressure a "hard" or "soft" cheese is produced. It is then left to ripen.

Cheddar cheese is a good one for examination.

Experiment.—Heat a little cheese on a crucible lid.

Note.—The cheese melts, and as it begins to decompose there is a strong smell. Ammonia fumes are given off, later acid fumes. The carbon burns away at red heat; a little mineral ash is left.

Experiment.—Warm some cheese with water.

Note.—An oily layer forms on the top, showing that the fat is separating out.

Experiment. — Break up some cheese into small pieces and shake up with ether in a test tube. Pour off the ether layer and leave to evaporate.

Note.—A soft fat is left.

Experiment.—Soften some cheese by warming with water. Pour off the water; add one drop of copper sulphate and a little caustic potash solution.

Note.—The violet colour characteristic of proteids is produced.

Experiment.—Soften a little cheese by warming with water, and test the solution for sugar.

Note. — Cheddar cheese does not generally contain any sugar.

COCOA AND CHOCOLATE

Fry's Pearl cocoa and any inexpensive chocolate powders are suitable for examination.

Experiment.—Heat a little on a crucible lid.

Note.—There is a pleasant smell, and as the cocoa begins to decompose a little alkaline gas is formed. Then acid fumes are given off, the carbon burns away, and mineral ash is left.

Experiment.—Warm some cocoa with water for a little time and then filter.

Test the filtered liquid for sugar by using copper sulphate and caustic soda solutions.

Note.—The grape sugar test is not given.

If the liquid be boiled for a minute with dilute hydrochloric acid, and then again tested, a good sugar reaction is given. The cocoa contains cane sugar.

Experiment.—Shake up a little dry cocoa with ether and let it stand. Pour off the colourless ether layer and leave it to evaporate.

Note.—A firm white layer of fat is left.

Experiment.—Warm some cocoa with water, then add iodine.

Note.—The blue colour shows starch to be present.

The cocoa contains a little proteid, fat, sugar, starch, and mineral ash. The different cocoas differ very much in their relative amounts of these substances.

It is interesting to have different samples of cocoa, and to try and dissolve out the proteid matter. The cocoa can be simmered with water for about twenty minutes, then filtered, and the filtrate tested with dilute acids in the usual way.

CHAPTER VI

VEGETABLES

THE POTATO

Experiment.—Peel a potato and take out the "eyes".

Note.—When the skin is removed the surface is very wet. It is evident that the potato contains a large quantity of water.

Experiment.—Weigh a small dish. Put in a piece of potato, and weigh again. Leave in the air oven at a temperature of 100° C. for some time. Then cool and weigh. Continue the experiment until there is no more loss of weight.

Note.—About 75 per cent of the potato is water.

Experiment.—Heat a small piece on a crucible lid.

Note.—Water is given off, and a very small quantity of ammonia fumes. The potato blackens; the carbon burns away at red heat. Some mineral matter is left, which is found to be soluble in water.

Experiment.—Test for starch and sugar.

Note.—Starch is found to be present in large quantities. The amount of sugar varies; sometimes there is practically none, sometimes a perceptible amount.

Experiment.—Cut up some pieces of potato. Put into a large test tube, and cover with cold water; put in a thermometer. Put the test tube into a beaker of water, and keep the water at 60° C. for about one hour. Filter a little of the liquid, and test for proteid.

Note.—There is no coagulation either with heat or dilute acids.

Experiment.—Evaporate a little of the filtrate to dryness.

Note.—A residue is obtained, therefore the potato contains soluble matter.

Experiment.—Ignite the residue.

Note.—A small quantity of ammonia is given off. There is very little proteid matter present.

Experiment.—Test a little of the filtrate with iodine.

Note.—Starch is present.

The potato is seen to consist chiefly of starch and water. In cooking we must remember that we are cooking starch; but the methods can be modified, as the food itself contains 75 per cent of water.

Experiment.—Boil some water in a pan. Peel some potatoes, put them into the boiling water, adding a little salt. Cook until soft, keeping the water just below boiling, at a temperature of about 95° C. Then pour off the water, and test for starch. Warm the potatoes over a small gas flame, shaking the pan frequently until they are nearly dry. Then take away from the flame and shake well.

Note.—The potato water gives the starch test. The potatoes should be dry and mealy.

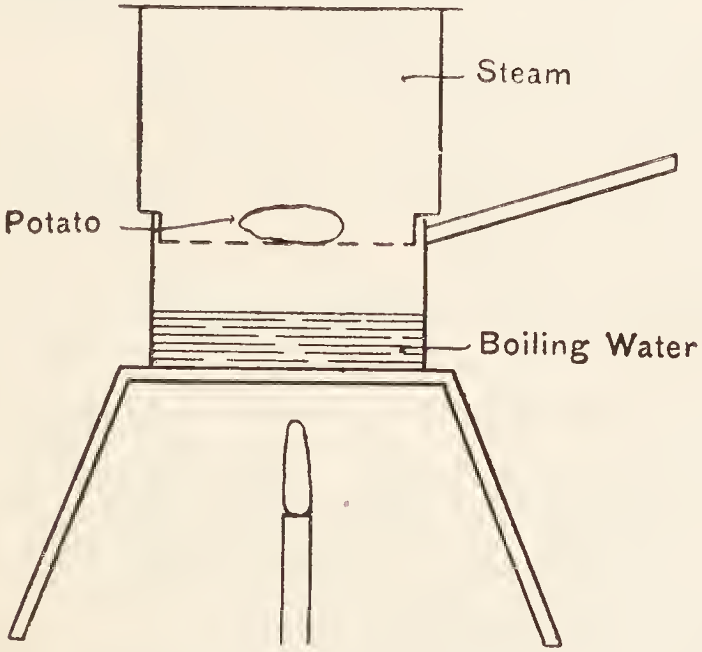

Fig. 7.—Diagram of Steamer

Experiment.—Put some peeled potatoes in a steamer over a saucepan of boiling water.

Sprinkle them with salt, and put on the steamer lid. Leave them until soft. Then take off the steamer and leave in a warm place until dry.

Note.—The potatoes should be dry and mealy; the water in the saucepan contains a little starch.

Experiment.—Scrub some potatoes, and take out the "eyes". Put them into boiling water, adding a little salt. Cook until soft, keeping the water at 95° C. Then pour off the water, filter it, and test for starch. Put the potatoes on a cloth in a dish, and leave in a warm place until dry.

Note.—The potatoes should be dry and mealy.

The water contains a little starch.

Steaming is a better method of cooking than boiling, as there is less waste of soluble material. When potatoes are boiled in their skins most of the soluble substances are retained.

If potatoes are left standing in water after being cooked, the starch will absorb more water and become sodden. On account of the large percentage of water they contain, potatoes can be baked.

When potatoes are peeled they go brown if left exposed to the air. Consequently they are usually left covered with cold water. If left too long, however, it is evident that the soluble substances will dissolve out.

The potato is the swollen underground stem of the plant. When kept in warmth and darkness small pale shoots come out from the "eyes". If put in the ground a new plant will appear and the potato gradually shrivels away. It is the storehouse for the food. When it sprouts, the food is used up for the nourishment of the new shoots.

ROOT VEGETABLES

Carrot, turnip, and parsnip are root vegetables. The swollen root is the storehouse for the plant's food.

Experiment.—Heat a little of each vegetable on a crucible lid.

Note.—Steam is given off, and a trace of ammonia as the substance chars. Mineral ash is left.

Experiment.—Find the percentages of water and mineral ash in the same way as before.

Note.—

Carrot	contains about	86	per cent	water.
Turnip	,,	90	,,	,,
Parsnip	,,	80	,,	,,
Carrot	,,	.9	,,	ash.
Turnip	,,	.8	,,	,,
Parsnip	,,	1.3	,,	,,

Experiment.—Put some pieces of each vegetable into water; heat to boiling. Boil until soft. Test the softened vegetable for starch.

Note.—Parsnip contains a great deal of starch.

When the carrot is heated with water, a little colouring matter comes out, but no starch is found either in the water or the vegetable.

There is generally a great deal of starch in the water in which the parsnip has been cooked.

Experiment.—Test the waters for sugar.

Note.—The waters from the carrot and turnip give good sugar reactions.

The test, as a rule, does not work satisfactorily with parsnip water. From the sweet taste parsnips may contain cane sugar.

Experiment.—Boil up a little of the parsnip water with dilute hydrochloric acid, then test for sugar.

Note.—The liquid gives a good sugar reaction, therefore the parsnip contains cane sugar.

It is impossible to avoid loss of nutritive material when these vegetables are boiled. The best way of boiling is to put them into boiling salted water, and boil until they are soft.

THE CABBAGE

We eat the leaves and the upper portion of the stem. The tough thick lower part is cut off. If cabbages are freshly pulled the leaves are crisp, stiff and turgid. If they have been kept for some time the leaves become soft and flaccid.

The following results have been obtained with a freshly pulled savoy cabbage.

Experiment.—Weigh a basin. Weigh again with a piece of cabbage. Leave until the next lesson. Then weigh again.

Note.—In twenty-four hours there is a loss of weight. This is due to the evaporation of the water, and it is for this reason that vegetables when not quite fresh are soaked in water before cooking.

Experiment. — Weigh a crucible. Weigh again with a small piece of cabbage leaf. Heat in an air oven at 100° C. for one and a half or two hours. Weigh again. Continue the heating until the weight is constant.

Note.—The loss of weight due to the water evaporated is 89 to 90 per cent.

Experiment.—Heat a small piece of cabbage in a crucible.

Note.—Steam is given off, then the cabbage begins to decompose. A characteristic smell is noticed. A trace of ammonia is given off, showing that a small amount of nitrogenous matter is present. Mineral ash is left.

Experiment. — Find the amount of mineral ash left.

Note.—About 1.5 per cent is obtained.

Experiment.—Put a few pieces of one of the outside leaves into a beaker of water. Heat to boiling and boil until the leaves are soft. Test the liquid and the cabbage for starch.

Note.—The water becomes green, showing that the green chlorophyll is being dissolved out. A little starch is found in the leaves, but the liquid does not give the starch reaction.

The inner yellow leaves contain starch; the water in which they have been boiled is yellow.

If the cabbage be kept for a few days before using, very little starch is found in the leaves.

If sugar is present in cabbage leaves, some will probably be dissolved out and be found in the cooking water.

Experiment.—Test the water in which outside and inside leaves have been boiled, for sugar.

Note.—It is found in both solutions.

From the results obtained it is evident that the cabbage has small nutritive value. Nearly 90 per cent is water; there is only a trace of proteid, a certain amount of carbohydrate, and mineral ash. But, though of little use as food, green vegetables are necessary for health, and the salts are specially valuable to the body.

The best method of cooking is one that will soften the leaves and stem, and at the same time dissolve out as little substance from the cabbage as possible. For this reason a cabbage is boiled quickly. Salt or salt and soda are generally put into the cooking water.

Experiment.—Boil some water in four enamel saucepans. Into A put some bicarbonate of soda in the proportion 1 teaspoonful to 1 gall. of water. Into B put soda in the same proportion, and salt in the proportion 2 tablespoonfuls to 1 gall. of water. Into C put salt in the same proportion as in B. In D is water only. Wash the cabbage well in cold water. Quarter it, cutting off the tough stem. Put one piece into each saucepan. Boil until soft. Take out and drain. Examine the different liquids and pieces of cabbage.

Note.—The pieces in B and C have the best colour. That in D is yellow and faded. That in A is better than in D but not so good as those in B and C.

The liquids are yellow or yellowish green in colour. That in C is the palest.

Experiment.—Test all the liquids for sugar.

Note.—As the liquids in A and B contain soda, they must be first neutralized with dilute acid and the carbon dioxide boiled away, before the sugar test can be applied. When dilute hydrochloric acid is added, the colour of the liquid at once disappears, but reappears on the addition of alkali. Sugar is found in all the four liquids.

When cabbages are boiled there is a loss of nourishment which cannot be avoided. The colour is kept best by boiling with salt, or with salt and soda, in the water. The soda seems to deepen the colour.

PEAS, BEANS, AND LENTILS

Peas, beans, and lentils are the seeds in which food materials are stored up for the development of the young plant.

Experiment.—Heat a few dried peas on a crucible lid.

Note.—As the peas begin to char a large amount of ammonia fumes is given off. The peas catch fire and burn, leaving mineral ash. Evidently a large amount of proteid is present.

Experiment.—Put some peas into cold water. Heat and simmer gently until they are soft, then crush them in a mortar, and again simmer; filter.

Note.—If the proteid is soluble, some will probably be dissolved in the water.

Experiment.—Test the filtrate with—

(1) a little strong nitric acid,
(2) dilute nitric acid,
(3) a drop of copper sulphate solution and caustic potash solution.

Note.—Coagulation takes place with the acids. The purple coloration is produced with the copper sulphate and potash. These results show the presence of soluble proteid. The proteid does not coagulate on heating.

Experiment.—Test the softened peas with copper sulphate and potash.

Note.—A purple coloration is produced.

Experiment.—Test the filtrate and the softened peas with iodine.

Note.—A large quantity of starch is found.

Experiment.—Test the filtrate for sugar.

Note.—No sugar is found.

Peas are specially rich in proteid and starch.

Similar results are obtained with lentils, which soften very quickly when simmered.

Haricot beans are very hard and have to be simmered longer than either peas or lentils. Even when the beans are soft, proteids can often *not* be found in the filtrate, though the softened beans give the purple colour with copper sulphate and caustic potash.

Both peas and beans soften more quickly if soaked beforehand.

CHAPTER VII

FRUITS AND NUTS

APPLE

It is evident that a large amount of water is present.

Experiment.—Determine the percentage of water in the usual way.

Note.—About 83 to 84 per cent water is obtained.

Experiment.—Boil up a little apple with water and test for starch.

Note.—No starch is obtained. The liquid has an acid reaction.

Experiment.—Test for sugar with copper sulphate and caustic potash solutions.

Note.—Sugar is present.

Experiment.—Heat a small piece of apple on a crucible lid.

Note.—As the substance decomposes, a very slight trace of alkaline gas is given off, the carbon burns away at red heat, and mineral ash is left.

The apple contains water, sugar, acid, and a small amount of mineral substance.

If other fruits, such as plums, gooseberries, strawberries, &c., are examined, they are found to have a very similar composition, consisting chiefly of water, acid, and sugar.

BANANAS

Experiment.—Heat a small piece of banana on a crucible lid.

Note.—Sticky melted sugar oozes out from the surface. The substance then browns, catches fire, the black carbon burns away at red heat, mineral ash is left.

Experiment.—Soften some banana by heating with water.

Test the soft solid with iodine.

Note.—A large amount of starch is found.

Experiment.—Test the liquid for sugar with copper sulphate and caustic potash solutions.

Note.—Grape sugar is found to be present.

Experiment. — Determine the percentage of water. Weigh a crucible; weigh a crucible and

and a piece of banana. Heat in an air oven at 100° C.

Let cool and weigh again.

Note.—About 73 or 74 per cent of water is obtained. The banana consists chiefly of water and carbohydrates.

THE WALNUT

Experiment.—Heat a piece of nut on a crucible lid.

Note.—As the substance begins to decompose, the disagreeable smell of burning proteid is noticed. A large quantity of ammonia is given off, then there is the smell of burning fat, and the charring substance liquefies and catches fire, burning with a bright flame. Acid fumes are given off; the carbon burns away at red heat. Mineral ash is left. It is evident that the nut consists chiefly of proteid and fat.

Experiment.—Cut some nut into small pieces. Soften by boiling with water and pounding in a mortar. Take some of the cloudy liquid in a test tube. Add ether. Shake up.

Note.—Three layers are seen. A colourless layer at the top, then the bits of solid forming a layer with a curious oily appearance, then the water. If the ether is poured off and left to evaporate, a colourless strong-smelling oil is obtained.

Experiment.—Test the softened nut for starch

Note.—No starch is present.

If the liquid be tested for sugar no sugar is obtained.

Experiment.—Try to dissolve out the proteid by cooking the nuts in water and gently simmering.

Note.—The proteid appears to be insoluble in water. The filtered liquid gives no coagulation with copper sulphate solution or the acids. It does not give a purple colour with copper sulphate and potash. If the soft pieces of nut are tested with copper sulphate and potash, a purple colour is obtained.

The nut consists chiefly of proteid and fat.

THE BRAZIL NUT

Experiment.—Heat a small piece of nut on a crucible lid.

Note.—The characteristic smell of burning proteid is noticed, and a large quantity of alkaline fumes evolved. Oil oozes out from the cut surface. There is the smell of burning fat; the substance catches fire, burning with a bright flame. Acid fumes are evolved. Finally the carbon burns away at red heat. Mineral ash is left.

Experiment.—Soften the nut by cutting into small pieces and heating with water. Filter. Test the soft solid and the filtrate with a drop of copper sulphate solution and caustic potash solution.

Note.—The purple colour is obtained with the solid but not with the filtrate.

The proteid is insoluble in water.

Experiment.—To the softened nut and water add ether. Shake up and pour off the ether layer.

Note.—As in the case of walnut, three layers are seen. When the ether has evaporated a colourless strong-smelling oil is left.

Brazil nuts contain proteid and fat.

Nuts are very rich in food substances. They contain a very small amount of water and sometimes as much as 60 per cent of fat.

Chapter VIII

FLOUR AND BAKING SODA

Flour is prepared from wheat grains.

Examine the appearance and feeling of white flour.

Experiment.—Heat a little flour on a crucible lid.

Note.—The flour soon blackens and begins to decompose. Ammonia fumes are given off. The carbon burns away at red heat. Flour evidently contains a proteid substance. Its appearance and feeling suggest that starch is present.

Experiment.—Test for starch with iodine.

Note.—It is found to be present in large quantities.

Experiment.—Add a little cold water to flour.

Note.—A stiff elastic dough is formed.

The action of water on pure starch is very different from that on flour. The substance in flour which makes dough elastic is probably the proteid. It is possible that the proteid and the starch may be separated by the action of cold water.

Experiment.—Wrap a little dough in a piece of muslin or nainsook. Squeeze in a beaker of cold water.

The water becomes cloudy, and if a little be tested with iodine the starch reaction is given. Continue the washing until no more starch comes out, then examine the substance left in the muslin.

Note.—A yellowish elastic substance is left. This is evidently insoluble in water.

Experiment.—Heat a little on a crucible lid.

Note.—The substance chars; a large quantity of ammonia is given off.

This is the proteid constituent of flour, and is called gluten.

Experiment.—Compare the amounts of gluten in several different flours: Hungarian, household, standard, &c. Weigh 10 g. of each kind of flour. Add water from a tap measure until a stiff dough is formed. See how much water is needed. Put each dough into muslin. Wash out all the starch. Put the gluten into a weighed crucible. Dry at 100° C., and weigh again.

Note.—Flour contains from 10 to 13 per cent of gluten. The more gluten there is, the greater the amount of water needed to make a dough.

Experiment.—Examine the gluten.

Note.—It has become hard and brittle and has darkened in colour. It cannot be restored to its former condition by soaking in water. It is very difficult to remove from the crucible, which has to be cleaned by burning off the gluten.

USE OF YEAST IN BREAD MAKING

Experiment.—Make two specimens of dough, one consisting of flour and water, the other of flour and water into which a little yeast mixed with milk, or sugar and water, has been put. Cover each basin and leave in a warm place, at 25° to 30° C., for about twenty minutes. A warm sand bath answers the purpose.

Note.—The dough containing the yeast is light and spongy and has much increased in size.

The processes in bread making are generally as follows: The yeast is mixed with sugar and water or with milk, and put in a hole in a basin of flour. The basin is then put away in a warm place. The temperature is right for the yeast to act on the sugar. Fermentation begins; the sugar is changed to alcohol and carbon dioxide. The bread is mixed and kneaded so that the gas may be distributed throughout the mass. It is then left to "rise". More gas is made, which in its expansion divides the gluten. When the bread is baked, further expansion takes place and the "holes" are formed. The alcohol evaporates in the process of baking. The yeast is killed.

EXAMINATION OF BAKING SODA

Examine the appearance and feeling of bicarbonate of soda.

Note.—The soda is a soft white powder which sticks together in lumps.

Experiment.—Heat a little soda in a crucible.

Note.—There is no change of colour, the soda seems to shrink and stick together.

Experiment.—Weigh a crucible; weigh a crucible and about 5 g. soda. Heat strongly for about ten minutes, let cool, and weigh again. Heat again to see if there is a further loss in weight.

Note.—A loss in weight of about 36 per cent observed.

Weight of crucible	7.52 g.
,, ,, ,, and soda	8.27 g.
,, after heating	8.00 g.
Loss of weight	.27 g.
Weight of soda taken	.75 g.

$\therefore$ .75 g. of soda lose .27 g. on heating.

$$100 \quad ,, \qquad ,, \quad \frac{.27}{.75} \times 100 = 36 \text{ g.}$$

Experiment.—Put a little soda into a test tube; half-fill the test tube with water; shake up.

Note.—The soda is dissolved slowly.

The solution is alkaline to litmus paper.

Experiment.—Heat some soda and water to see if solution takes place more quickly.

Note.—The soda dissolves more quickly when the liquid becomes hot; effervescence takes place.

Experiment.—Pour some boiling water on a little soda in a test tube.

Note.—Effervescence takes place very rapidly.

Experiment.—When all effervescence is over, test the liquid in the test tube with litmus paper.

Note.—It is very alkaline.

Experiment.—Try the effect of dilute acid on baking soda.

Note.—The soda dissolves with rapid effervescence.

Experiment.—Dissolve a little baking soda in cold water, put into a porcelain dish. Colour with litmus solution. Add dilute hydrochloric acid drop by drop from a burette until the liquid is purple; then evaporate.

Note.—Each drop of acid causes effervescence. When the liquid is evaporating it turns blue, and a little more acid has to be added. This has to be done several times in the course of evaporation. Finally a purple-coloured solid is obtained. This has the taste of salt.

Salt is also obtained when washing soda is neutralized with dilute hydrochloric acid.

Experiment.—To collect and examine the gas made by the action of dilute hydrochloric acid on baking soda.

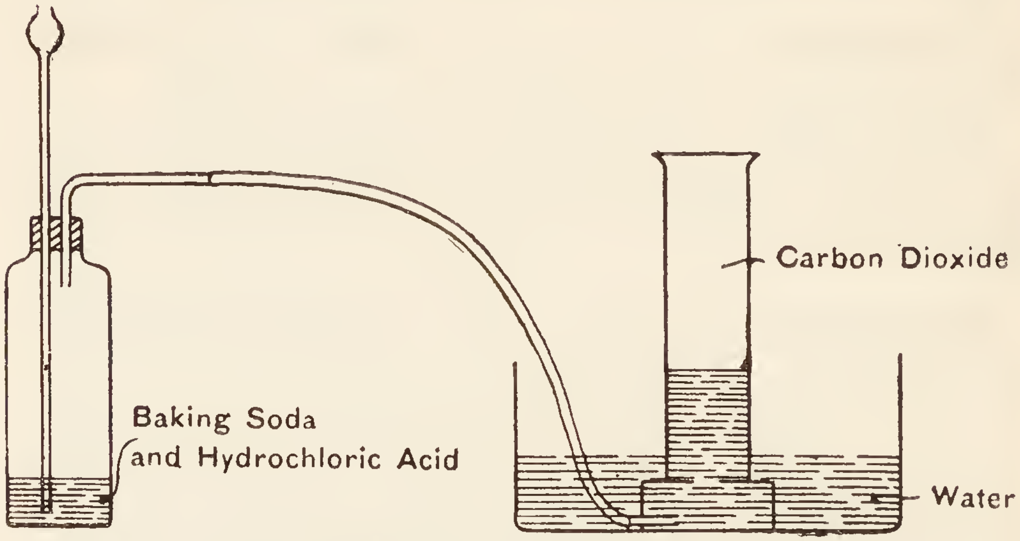

Fig. 8.—Diagram of Apparatus for collecting Gas given off from Baking Soda and Hydrochloric Acid

Put some baking soda in a wide-necked bottle. Cover it with cold water. Put a two-holed cork in the bottle, provided with a thistle funnel and delivery tube. Arrange the apparatus as shown in the diagram. Pour the dilute acid slowly down the thistle funnel. Collect the gas over water.

Test the first jar with a lighted taper.

Test the second jar with litmus solution.

Note.—The gas puts out the taper and does not burn itself. When purple litmus solution is poured in, and shaken up with the gas, it is slowly turned red, in the same way that it is turned by carbon dioxide. The gas is also found to be heavier than air, and acts on lime water, changing the lime to chalk.

Dilute hydrochloric acid and baking powder make carbon dioxide.

To test the gas made when boiling water is poured on baking soda.

Experiment.—Put some soda in a bottle and arrange the apparatus as shown in the diagram. Boil a little water in a test tube and pour it down the thistle funnel. Pass the gas into lime water.

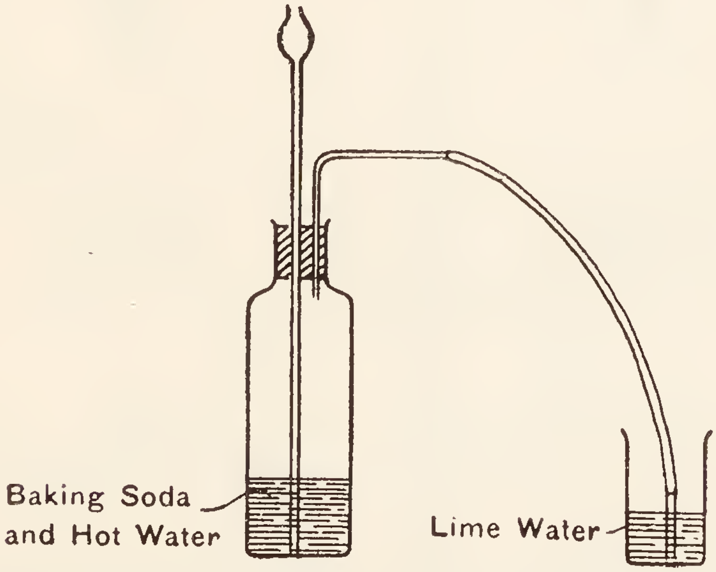

Fig. 9.—Diagram of Apparatus used to show that Carbon Dioxide is given off by action of Hot Water on Baking Soda

Note.—The lime water becomes chalky, showing that the gas is carbon dioxide.

Experiment.—To see whether carbon dioxide is made when baking soda is heated.

Put some soda in a test tube and arrange the apparatus as shown in the diagram. Gently heat the test tube containing the soda.

Note.—Drops of water are seen at the mouth of the test tube; the lime water slowly turns milky, the chalk film forming at the top of the water as the gas meets it.

To examine the residue left after baking soda is heated.

Experiment.—Heat some baking soda in a crucible until the weight is constant. Then examine the residue.

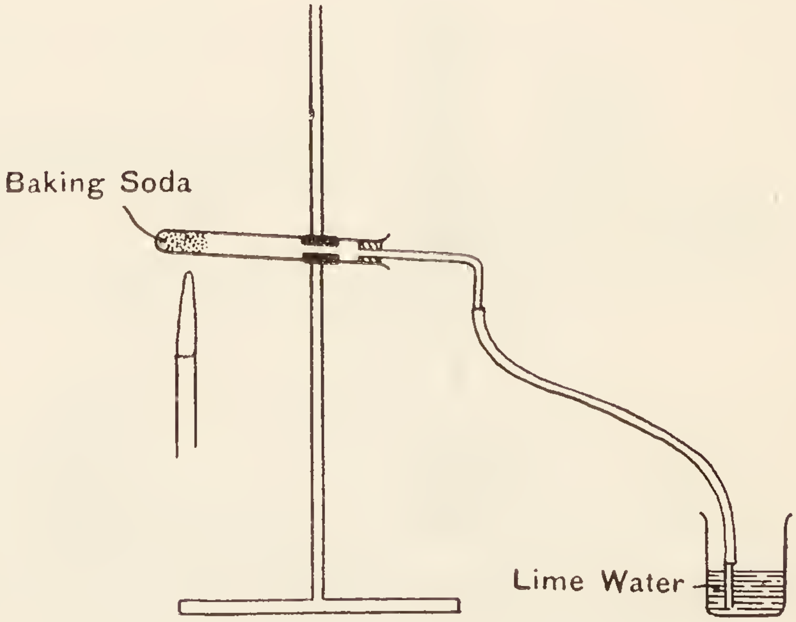

Fig. 10.—Diagram of Apparatus used to show that Carbon Dioxide is given off when Baking Soda is heated

Note.—It is a white powder, which dissolves in water, making a strongly alkaline solution.

Dilute acids cause effervescence, and the gas is found to be carbon dioxide. When the solution of the powder is neutralized with dilute hydrochloric acid, salt is formed.

The powder is like that obtained by heating washing soda. This is called washing soda powder or carbonate of soda. For a final test we can find the weight of gas in heated baking soda and in carbonate of soda.

Experiment.—Take a small test tube or ignition tube which will fit into a flask and take the positions shown in A and B. Weigh the tube. Put about 1½ or 2 g. carbonate of soda in the tube and weigh again. The soda must not be packed too tightly. Weigh a small flask about a quarter full of dilute hydrochloric acid, and provided with a cork and calcium chloride tube. Put in the soda tube carefully, so that the acid does not meet the soda (fig. 11A). Put in the cork, then tilt the flask, and allow the acid and soda to react (fig. 11B). Let all the gas come off, then weigh again.

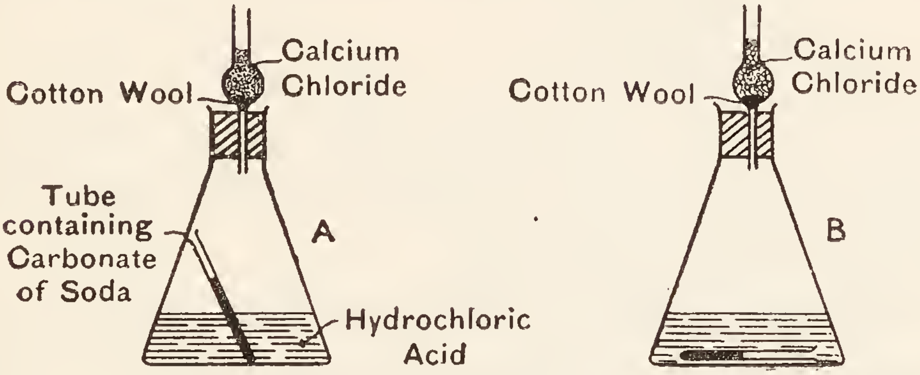

Fig. 11.—Diagram of Apparatus used to find percentage weight of Gas given off from Carbonate of Soda by action of Hydrochloric Acid

		grammes.
Weight of flask, chloride tube, and acid	=	75·74
Weight of small tube	=	2.36
,, ,, and soda	=	3.86
∴ Total weight	=	81.96
Weight after the gas has been given off	=	81.34
∴ Weight of gas given off	=	.62
1.5 g. carbonate of soda give off		.62
∴ 100 g. carbonate of soda give off $\frac{.62 \times 100}{1.5}$	=	41.5

If a second experiment be made, with the powder obtained by heating baking soda, the same result is obtained.

Therefore baking soda when heated loses carbon dioxide and water, and carbonate of soda is left.

THE USE OF BAKING SODA

Experiment.—Make a little dough by mixing flour and water in a porcelain dish. Make another sample, but first add a pinch of baking soda to the flour. Put each dough on to a floured sheet and bake in the air oven.

Note.—The dough without the baking soda is heavy and close; the other has expanded considerably, and is found to be light and spongy in texture.

CHAPTER IX

THE DIGESTION OF STARCH IN AN INVALID FOOD

BENGER'S FOOD

Experiment.—Heat a little of the dry powder.

Note.—As it begins to decompose, a large quantity of ammonia is given off. Then the substance burns and chars. The carbon burns away at red heat.

It is obvious that a good deal of nitrogenous substance is present.

Experiment.—Shake up a little powder with cold water. Add 1 drop of copper sulphate solution and some caustic potash solution.

Note.—The colour seems to be intermediate between proteid and peptone.

Experiment.—Test the damp powder for starch and sugar.

Note.—Starch is found to be present in considerable quantity. There is practically no sugar.

Experiment.—Prepare some Benger's food according to the directions, but using water only. Test the prepared food for starch and sugar.

Note.—Starch is present, but now there is a good sugar reaction.

The first stage in the digestion of starch is its conversion into a soluble sugar of the class to which grape and milk sugar belong. This process begins in the mouth by the action of the saliva. It is continued in the intestine.

The Benger powder contains starch and pancreatine—one of the constituents of the digestive juice of the intestine. When the powder is mixed with warm milk and water, and left to stand, the pancreatine is able to act on the starch and convert it to sugar.

WELLCOME LIBRARY INSTITUTE